Title: Exploring Transformations

Brief Overview:

Students will explore representations of transformational geometry on a four quadrant coordinate plane. Emphasis is placed on patterns among coordinates as shapes are translated, reflected, and rotated.

NCTM Content Standard/National Science Education Standard:

Geometry – Apply transformations and use symmetry to analyze mathematical situations. Describe sizes, positions, and orientations of shapes under informal transformations such as flips, turns, slides, and scaling.

Grade/Level:

Grades 6 – 8

Duration/Length:

Four 45 – minute lessons

Student Outcomes:

Students will be able to:

- Translate (slide) a geometric figure on the coordinate plane and identify the coordinates of the translated figure.
- Reflect (flip) a geometric figure over the *x* and *y* axis and identify the coordinates of the reflected figure.
- Rotate (turn) a geometric figure 90 and 180 degrees around the origin (clockwise and counterclockwise) and identify the coordinates of the rotated figure.

Materials and Resources:

- Overhead projector
- Full sheet of transparency acetate
- Quarter sheet of transparency acetate
- Non–permanent colored transparency markers
- Straight edge
- Grid Sheet with a coordinate 4 quadrant grid
- Coordinate grid transparency
- Colored Pencils (red, blue, and green)
- Miras – one for each student
- Electrical tape
- Rope

- Analog clock transparency
- Copies of worksheets:
  - Grid Sheet
  - Translation Station
  - Translation Station Graph
  - Mira Mira on the Wall
  - Another Mira Mira on the Wall
  - Exploring Transformations
  - Analog Clock
  - Exploring Transformations
  - Triangle Grid Sheet
  - Find the Image
  - Scavenger Hunt

Development/Procedures:

Lesson 1:

Preassessment – Begin this lesson on translations by reviewing with the students how to locate and plot points on a four quadrant coordinate grid. Hand out the "Grid Sheet". Review the x and y axis and how to locate and plot points in all four quadrants. Students should also be able to add and subtract integers to each ordered pair to discover the new ordered pair. Review the definition of an ordered pair and insure students understand the correct method to identify a point. (x, y).

Launch – Pass out new copies of the "Grid Sheet". Have the students plot (2 , 4) , (4 , 2) and (7 , 2) on the Grid Sheet and label the points *A, B, C*. Ask the students: "If I connect the ordered pairs, what figure do I form? What quadrant is the triangle in?"

Have the students connect the points with a red pencil to form the triangle. Explain that they are going to place their blue pencil on vertex *A* of the red triangle and count 5 units to the left and draw a new point and label it A_1. Have the students do the same with the other two points of the triangle and connect the new points. Ask the students: "Is the blue triangle congruent to the red triangle? What type of movement did the triangle make to move from the red to the blue triangle?"

Have the students place their green pencil on vertex A_1 of the blue triangle. Have the students count 6 units down, draw a new point, and label it A_2. Have the students do the

same with the other two points of the blue triangle and connect the three points. Ask the students: "Is the green triangle congruent to the blue triangle? Is the green triangle congruent to the red triangle? What type of movement did the green triangle make from the blue triangle? What type of movement did the green triangle make from the red triangle?"

Teacher Facilitation – Tell the students that they have been exploring a type of transformation called translations. Translations are a type of transformation where you slide a geometric figure across the coordinate plane.
Hand out new copies of the "Grid Sheet". Give each student a quarter sheet of acetate and a non–permanent colored transparency marker. Have the students draw a red house in the third quadrant with ordered pairs (–4,–5), (–8,–5), (–8,–3), (–6,–1), (–4,–3), (–4,–5).

Have the students place the acetate in the third quadrant on top of the red house and carefully trace the house with their transparency marker and a straight edge. Now move the transparency acetate 3 units to the right and 7 units up. Model these steps on the overhead.

Have the students find the vertices of the house on the coordinate plane and trace the house with their blue pencil on the grid sheet. Explain that this is a translation of $(x + 3)$ and $(y + 7)$. Emphasize that the red house is the pre–image and the blue house is the image.

Have the students place the transparency acetate on blue triangle and translate (slide) 6 units to the right and 2 units down $(x + 6)$, $(y – 2)$. Have the students find the vertices and use their green pencils to trace the house. Again emphasize that the green house is now the image and the blue house is the pre–image of the green house. Point out that all of the houses are congruent to each other. Encourage the students to develop their own translations, using the appropriate vocabulary of 'translation' to describe the transformation. Walk around the room to monitor their progress.

Student Application – Hand out "Translation Station" and "Translation Station Graph" and have the students work with a partner to determine the solutions. Remind the

students to carefully find the ordered pairs before moving on to the next step.

Embedded Assessment – Carefully discuss the Translation Station worksheets and collect them to determine if the students correctly grasped the concept.

Reteaching/Extension
- Students who are having trouble with translations may need to work with simple figures and/or review points on the coordinate plane.
- As an extended assignment you may want to have students make a coordinate plane flip booklet where they perform the same translation on a geometric figure multiple times and flip the pages to show the translation.

Lesson 2:

Preassessment – This lesson focuses on reflection of images. From experiences in prior grades, the students should already understand that reflections will produce congruent shapes. Ask the students, "What do you see when you look in a mirror? How is the image the same as the original? How is the image different than the original?" Ask the students to explain what a polygon, such as a rectangle, would 'see' if it looked at itself in a mirror. Have the students compare this answer to what a triangle would 'see' in a mirror. Ask the students to explain why the reflections would be different for a triangle.

Launch – Provide the students with a copy of "Mira Mira on the Wall" and a Mira. Have the students place the Mira on the y–axis and describe the reflection of the rectangle shown in the Mira. Instruct students on how to use the Mira to draw the reflected image onto the coordinate grid. Repeat the activity using the triangle on "Another Mira Mira on the Wall". For an extension activity, have students reflect over the x – axis as well. Have the students draw comparisons between their responses about a person's reflection in a mirror versus the polygons' reflections on the coordinate grid.

Teacher Facilitation - Provide the students with another copy of the "Grid Sheet" (from the first lesson) and the new worksheet, "Exploring Transformations". Have the students plot the points (3, 2), (4, 6), (8, 8), and (9, 2) on the "Grid Sheet".

Provide the students with a sheet of acetate, a straight edge, and a transparency pen. Have the students place the edge of the acetate on the *x*–axis. Instruct the students to use the transparency pen and a straight edge to trace the quadrilateral. (Model this activity on a transparency of the Grid Sheet.) Have the students keep the edge of the acetate on the *x*–axis and flip the acetate over. The resulting figure should now be visible through the acetate in the fourth quadrant of the graph. Ask the students to plot the points for the vertices of the new figure and label the vertices with the coordinates. The resulting coordinates should be (3, –2), (4, –6), (8, –8), and (9, –2). Generate a class discussion to enable the students to determine the patterns in the *x* and *y* coordinates between the image and the pre–image.

Repeat the activity using the coordinates (–3, –1), (–5, –5), and (–8, –3) and reflect over the *x*–axis again. The resulting reflection will have the coordinates (–3, 1), (–5, 5), and (–8, 3).

Encourage the students to check the accuracy of the reflection by folding the paper on the *x*–axis and holding the paper up to a light. The students should only be able to see one copy of each figure.

Student Application – Provide the students with a clean copy of "Grid Sheet" and "Exploring Transformations". Repeat the activity using the original four coordinates and have the students reflect the quadrilateral over the *y*–axis. The resulting quadrilateral will have vertices at (–3, 2), (–4, 6), (–8, 8), and (–9, 2). Repeat the activity using the coordinates for the triangle, (–3, –1), (–5, –5), and (–8, –3) and have the students reflect the triangle over the *y*–axis. The resulting triangle will have vertices at (3, –1), (5, –5), and (8, –3). Ask the students to write a description of how reflections over the *y*–axis create a different pattern than reflecting over the *x*–axis.

Embedded Assessment – Assess the students' understanding by reviewing the graphs of the reflections and checking the coordinate labels of the vertices. Read the students' description of the patterns generated by the reflections.

Reteaching/Extension
- Construct a large coordinate grid on the floor of the classroom using electrical tape. Invite three students

to stand on three points of the coordinate plane. Ask the students to identify the coordinates. Record the coordinates on the chalkboard. Have the students hold a rope so that the rope creates a triangle. Invite three more students to stand on the coordinate grid so that they create a new triangle that is a reflection over the *y*–axis of the first triangle. Provide the students with a second rope to model the new triangle. Have the students identify the coordinates of the new triangle. Record the coordinates on the chalkboard. Generate a group discussion to determine the patterns evident when the original coordinates are compared to the reflected coordinates.

- Extend the concept by having the students construct a figure of their own on a blank grid sheet. Encourage the students to limit the number of sides for their polygon to less than eight sides. Have the students record step by step directions for reflecting the figure over either the *x* or *y*–axis.

Lesson 3:   Preassessment – To be successful with rotations, students will need to understand the concept of clockwise and counter clockwise, 90 degree and 180 degree rotations, quarter turns, and half turns. Introduce the concept of rotation by having students stand at their desks and rotate 90 degrees and 180 degrees both clockwise and counter-clockwise. Then, have students rotate quarter turns (45 degrees) as well as estimate other degrees (i.e. 30 degrees, 60 degrees, etc.)

Launch – Using the "Analog Clock" transparency, have students review the concept of clockwise and counterclockwise. Using the clock transparency, draw a 90 degree angle (essentially 3 o'clock). Have students recognize that the angle is ¼ of a circle, a ¼ turn, and a 90 degree rotation. Do the same for a 180 degree angle.

Teacher Facilitation – Using the transparency of "Grid Sheets", place a dot in the second quadrant. Label the coordinates. Overlay a sheet of acetate, and make a mark over the dot. Make reference points at the origin, (5, 0), (0, –5), (–5, 0), (0, 5). Rotate the acetate 90 degrees, being sure to line up the reference points. Have the students describe the process

and record the new point. Rotate the acetate another 90 degrees, and repeat.

Student Application – Assign the "Exploring Transformations" worksheet. Have the students plot the following trapezoid: A (–2, 1), B (–9, 1), C (–6, 4), D (–3,4). Have the students place the acetate over the figure they have drawn and trace it onto the acetate. They will mark points at the origin and at the 5's and –5's on the axes. Have the students rotate the acetate 90 degrees, and record the new figure, using the A_1, B_1, C_1, D_1 format.Have the students draw the figure on the grid. Have the students rotate the acetate 90 degrees again, and repeat the process above, using A_2, B_2, C_2, D_2 format.

Embedded Assessment – Check the worksheets for accuracy.

Reteaching/Extension
- Repeat the process using a coordinate grid where a right triangle has already been plotted for those who have not fully understood. Provide the students a copy of "Exploring Transformations" and "Triangle Grid Sheet".

- Extend the lesson by asking students to graph a pentagon using "Exploring Transformations" and "Grid Sheet". Have the students rotate the pentagon 180 degrees, and record the new figure on the worksheet. Students will draw the new figure on the grid sheet.

Summative Assessment:

Group Activity: Scavenger Hunt

Procedure:
- Hang the Scavenger Display Sheets (RS–A through RS–H) around the classroom. Be sure that they are not in order. Students may start at any Display Sheet.
- Hand out a copy of the "Scavenger Hunt Grid Sheet" to each student. Have the students answer the question at the bottom of the sheet. Direct the students to graph the figure that is described and then list the coordinates of the new figure below the first grid.
- Have the students find the display sheet with the answer that matches theirs and write the Answer Letter below their grid.
- Direct the students to do the question on the display sheet below the answer they found. Have the students graph the figure as described on their second grid, list the coordinates, and then find the graph that matches theirs.

- Have the students continue this process until they arrive back at the Scavenger Hunt Display Sheet where they started and all eight grids have been completed.
- The sequence of the sheets is F, C, H, A, E, B, G, D. The students may start at any of these letters, but the sequence will be the same.

Individual Assessment – Hand out a copy of Find the Image to each student and have the students work independently.

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Grid Sheet

Name:

_____
Exploring Transformations

Date: _____

Exploring Transformations   Name: _____
Translation Station   Date: _____
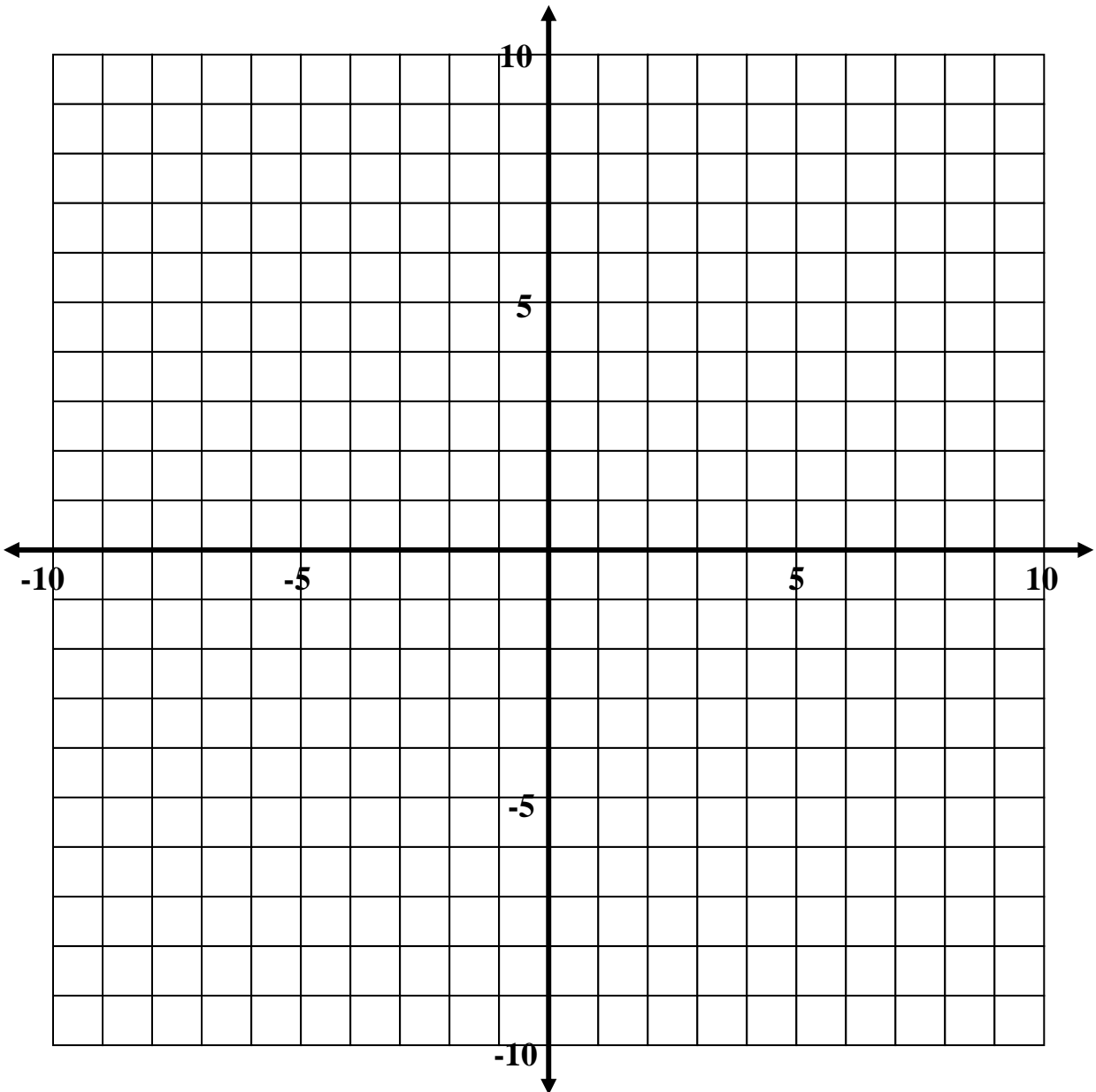
Materials: You will need Translation Station Graph, 2 colored pencils.

Procedure:
Step 1. Look at the truck on the worksheet. This is the pre–image.
⇒ What quadrant is this truck in? Quadrant _____

Step 2. Translate (slide) the truck 11 units to the left and 8 units down $(x - 11)$,
$(y - 8)$, and draw the truck using one of the colored pencils. This is the
first image. Label the corresponding points of *A, B, C, D, E* and *F* with A_1,
B_1, C_1, D_1, E_1 and F_1.
⇒ What quadrant is this image in? Quadrant _____

Step 3. Now translate your image 2 units to the right and 10 units up, $(x + 2)$,
$(y + 10)$, and draw this truck using the other colored pencil. This is your
second image. Label the corresponding points of A_1, B_1, C_1, D_1, E_1 and F_1
with A_2, B_2, C_2, D_2, E_2 and F_2.
⇒ What quadrant is this image in? Quadrant _____

Step 4. Record the coordinates for the first image. (1st figure that you drew)

A_1 (___,___), B_1 (___,___), C_1 (___,___), D_1 (___,___), E_1 (___,___), F_1 (___,___)

Step 5. Record the coordinates for the second image. (2nd figure that you drew)

A_2 (___,___), B_2 (___,___), C_2 (___,___), D_2 (___,___), E_2 (___,___), F_2 (___,___)

Step 6. What do you notice about the size of the three trucks on the graph? What
do you notice about their positions?

Step 7. How many units would you have to translate (slide) the 2nd truck that you
drew so that it would be in the same position as the original truck on the
graph?

Step 8. How many units would you have to translate (slide) the original truck so
that it would be in the same position as the 2nd truck that you drew?

.

Name: _____

Mira, Mira, on the Wall   Name: _____
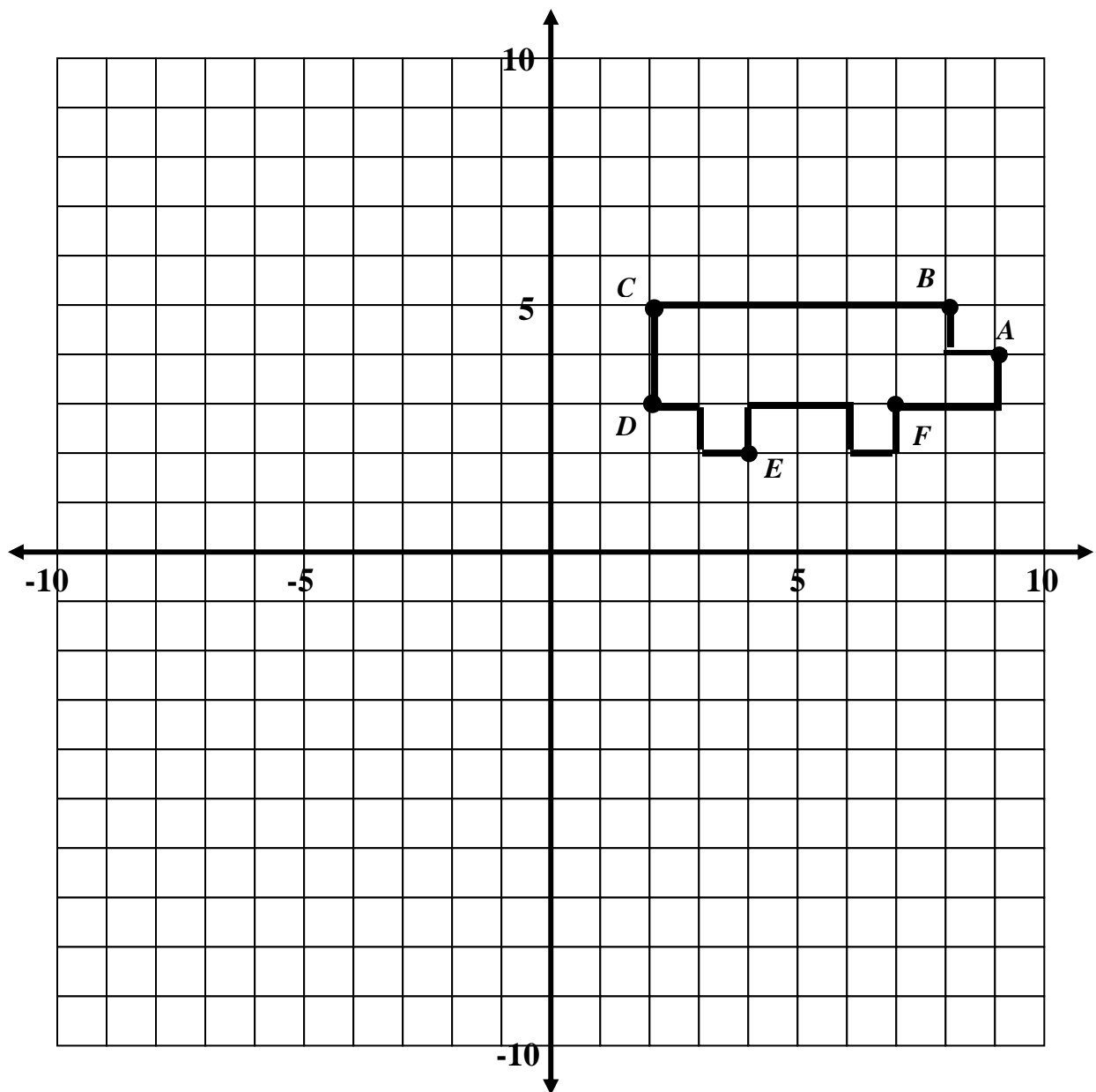
Place a Mira on the *y*–axis. Describe the reflection of the rectangle in the Mira.

_____

_____

_____

_____

Another Mira, Mira on the Wall   Name: _____
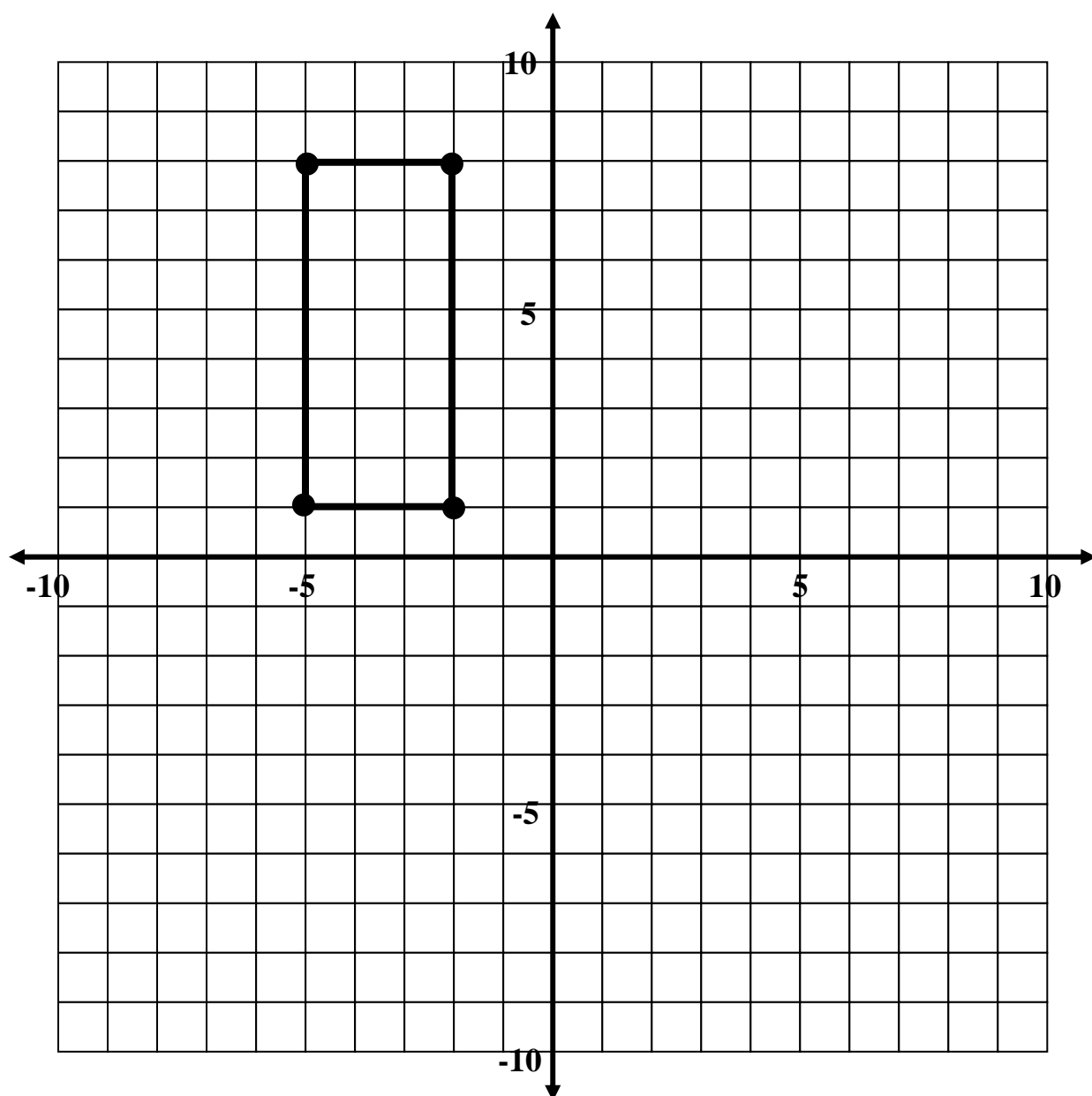
Place a Mira on the *y*–axis. Describe the reflection of the triangle in the Mira.
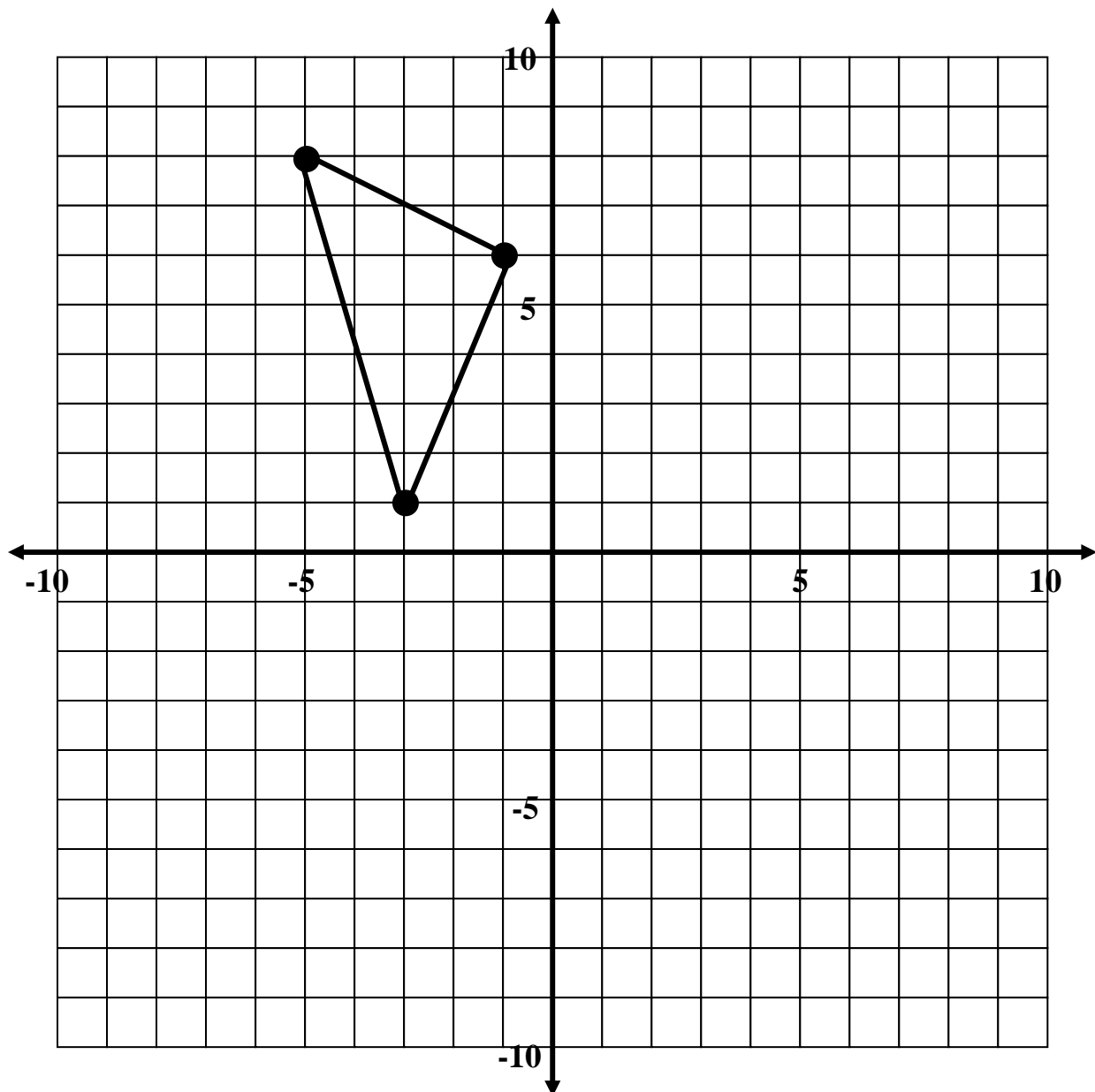
_____

_____

_____

_____

Exploring Transformations   Name_____
Reflections   Date: _____

Materials: You will need a Grid Sheet, pencil, 1 sheet of acetate, straight edge, and a transparency marker.

Procedure:

Step 1. Plot the following quadrilateral: $A(3, 2)$, $B(4, 6)$, $C(8, 8)$, $D(9, 2)$.

⇒ What quadrant is this figure in? Quadrant _____

Step 2. Place the edge of the acetate on the x–axis.

Step 3. Using the transparency marker, trace your quadrilateral onto the acetate. Label point A, B, C, and D, but do not copy the coordinates.

Step 4. Keep the edge of the acetate on the x–axis and flip the acetate over

Step 5. Record the coordinates for the new figure below.

A_1 (___,___), B_1 (___,___), C_1 (___,___), D_1 (___,___)

Step 6. Draw the new quadrilateral, and label Points A_1, B_1, C_1, D_1.

⇒ What quadrant is this figure in? _____

Step 7. What patterns do you see when you compare the first set of coordinates to the second set of coordinates?

Step 8. Plot the following triangle: $A(-3, -1)$, $B(-5, -5)$, $C(-8, -3)$.

⇒ What quadrant is this figure in? Quadrant _____

Step 9. Place the edge of the acetate on the x–axis.

Step 10. Using the transparency marker, trace your triangle onto the acetate. Label point A, B, and C, but do not copy the coordinates.

Step 11. Keep the edge of the acetate on the *x*–axis and flip the acetate over

Step 12. Record the coordinates for the new figure below.

A_1 (___,___), B_1 (___,___), C_1 (___,___),

Step 13. Draw the new triangle, and label Points A_1, B_1, C_1.

⇒ What quadrant is this figure in? _____

Step 14. What patterns do you see when you compare the first set of coordinates to the

second set of coordinates?

Exploring Transformations   Name _____
Reflections

Materials: You will need a Grid Sheet, pencil, 1 sheet of acetate, straight edge, and a transparency marker.

Procedure:

Step 1. Plot the following quadrilateral: $A(3, 2)$, $B(4, 6)$, $C(8, 8)$, $D(9, 2)$.

⇒ What quadrant is this figure in? Quadrant _____

Step 2. Place the edge of the acetate on the y–axis.

Step 3. Using the transparency marker, trace your quadrilateral onto the acetate. Label point A, B, C, and D, but do not copy the coordinates.

Step 4. Keep the edge of the acetate on the y–axis and flip the acetate over.

Step 5. Record the coordinates for the new figure below.

A_1 (___,___), B_1 (___,___), C_1 (___,___), D_1 (___,___)

Step 6. Draw the new quadrilateral, and label Points A_1, B_1, C_1, D_1.

⇒ What quadrant is this figure in? _____

Step 7. What patterns do you see when you compare the first set of coordinates to the second set of coordinates?

Step 8. Plot the following triangle: $A(-3, -1)$, $B(-5, -5)$, $C(-8, -3)$.

⇒ What quadrant is this figure in? Quadrant _____

Step 9. Place the edge of the acetate on the y–axis.

Step 10. Using the transparency marker, trace your triangle onto the acetate. Label point A, B, and C, but do not copy the coordinates.

Step 11. Keep the edge of the acetate on the *y*–axis and flip the acetate over

Step 12. Record the coordinates for the new figure below.

A_1 (___,___), B_1 (___,___), C_1 (___,___),

Step 13. Draw the new triangle, and label Points A_1, B_1, C_1.

⇒ What quadrant is this figure in? _____

Step 14. What patterns do you see when you compare the first set of coordinates to the second set of coordinates?

Analog Clock
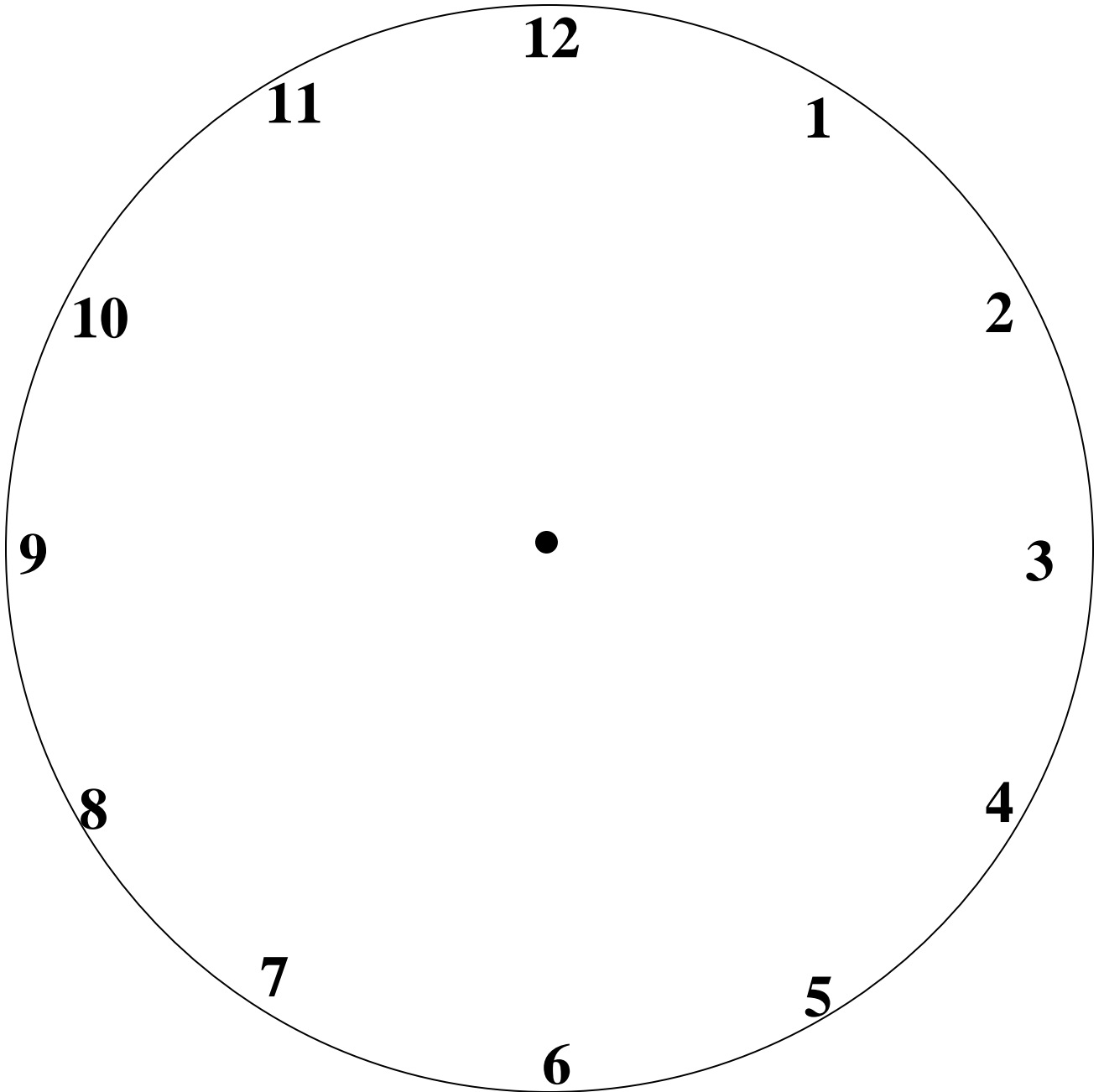
12

11

1

10

2

9

3

8

4

7

5

6

Exploring Transformations   Name_____
  Rotations

Materials: You will need a Grid Sheet, pencil, 1 full sheet of acetate, straight edge, transparency marker

Procedure:

Step 1. Plot the following trapezoid: $A(–2, 1)$, $B(–9, 1)$, $C(–6, 4)$, $D(–3, 4)$.
　　　⟹ What quadrant is this figure in? Quadrant _____

Step 2. Place the sheet of acetate over the grid. Using the transparency marker, make a
　　　small reference mark at the following: the origin, $(5,0)$, $(0,–5)$, $(–5,0)$, $(0,5)$.

Step 3. Using the transparency marker, trace your trapezoid onto the acetate. Label
　　　point A, B, C, and D, but do not copy the coordinates.

Step 4. Rotate your acetate 90 degrees clockwise on the origin. Be sure that the marks
　　　on the origin and the "5's" line up.

Step 5. Record the coordinates for the new figure below.

　　A_1 (___,___), B_1 (___,___), C_1 (___,___), D_1 (___,___)

Step 6. Draw the new trapezoid, and label Points A_1, B_1, C_1, $D_1.$
　　　⟹ What quadrant is this figure in? _____

Step 7. Rotate your acetate clockwise another 90 degrees around the origin.   Be sure
　　　that the marks on the origin and the "5's" line up.

Step 8. Record the coordinates for the new figure below.

　　A_2 (___,___), B_2 (___,___), C_2 (___,___), D_2 (___,___)

Step 9. Draw the new trapezoid, and label Points A_2, B_2, C_2, $D_2.$
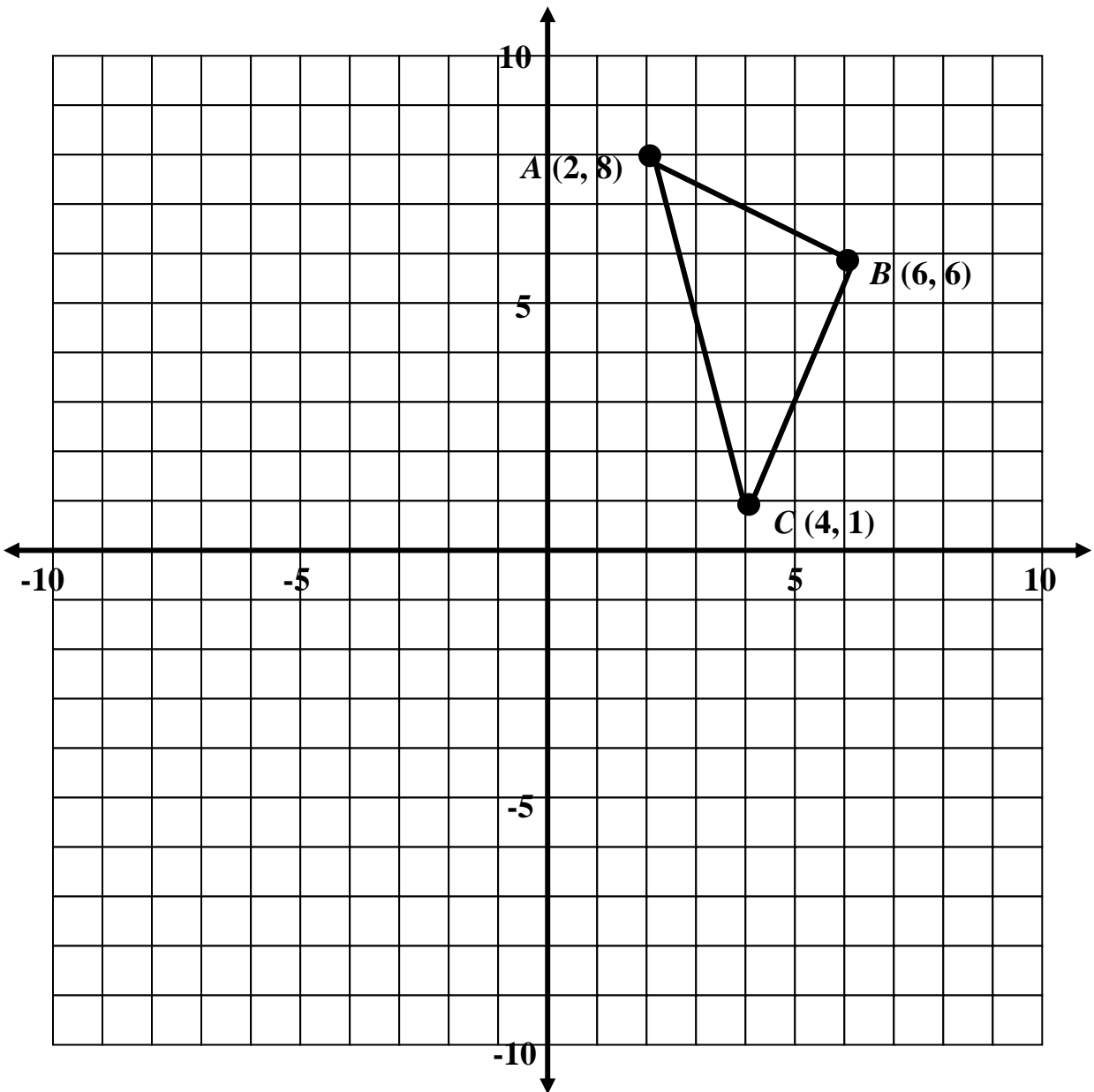　　　⟹ What quadrant is this figure in? _____

Step 10. Congratulations! You have completed the task! Take this sheet
　　　and your Grid Sheet to the teacher for your next task!

Exploring Transformations   Name_____
Rotating a triangle

Materials: You will need the Triangle Grid Sheet, pencil, 1 full sheet of acetate, straight edge, transparency marker

Procedure:
Step 1. Look at the triangle on the Triangle Grid Sheet.
   ⇒ What quadrant is it in? Quadrant _____

Step 2. Place the sheet of acetate over the grid. Using the transparency marker, make a small reference mark at the following: the origin, (5,0), (0,–5), (–5,0), (0,5).

Step 3. Using the transparency marker, trace the triangle onto the acetate. Label point A, B, and C, but do not copy the coordinates.

Step 4. Rotate your acetate 90 degrees clockwise on the origin. Be sure that the marks on the origin and the "5's" line up.

Step 5. Record the coordinates for the new figure below.

   A_1 (___,___), B_1 (___,___), C_1 (___,___)

Step 6. Draw the new triangle, and label Points A_1, B_1, C_1.
   ⇒ What quadrant is this figure in? _____

Step 7. Rotate your acetate clockwise another 90 degrees around the origin.   Be sure that the marks on the origin and the "5's" line up.

Step 8. Record the coordinates for the new figure below.

   A_2 (___,___), B_2 (___,___), C_2 (___,___)

Step 6. Draw the new triangle, and label Points A_2, B_2, C_2.
   ⇒ What quadrant is this figure in? _____

Step 7. Congratulations! You have completed the task! Take this sheet and Triangle Grid Sheet to the teacher for further instruction.

Triangle Grid Sheet

Name_____

Exploring Transformations

A (2, 8)

B (6, 6)

C (4, 1)

Exploring Transformations   Name_____
Rotating a Pentagon

Materials: You will need a Grid Sheet, pencil, 1 full sheet of acetate, straight edge, transparency marker

Procedure:
Step 1. Plot the following pentagon: $A(2, 3)$, $B(3, 5)$, $C(5, 4)$, $D(8, 7)$, $E(6, 1)$.
⇒ What quadrant is this figure in? Quadrant _____

Step 2. Place the sheet of acetate over the grid. Using the transparency marker, make a small reference mark at the following: the origin, $(5, 0)$, $(0, –5)$, $(–5, 0)$, $(0, 5)$.

Step 3. Using the transparency marker, trace your trapezoid onto the acetate. Label point *A, B, C, D,* and *E*, but do not copy the coordinates.

Step 4. Rotate your acetate 90 degrees clockwise on the origin. Be sure that the marks on the origin and the "5's" line up.

Step 5. Record the coordinates for the new figure below.

A_1 (___,___), B_1 (___,___), C_1 (___,___), D_1 (___,___),E_1 (___,___),

Step 6. Draw the new trapezoid, and label Points A_1, B_1, C_1, D_1 and E_1.
⇒ What quadrant is this figure in? _____

Step 7. Rotate your acetate clockwise another 90 degrees around the origin.   Be sure that the marks on the origin and the "5's" line up.

Step 8. Record the coordinates for the new figure below.

A_2 (___,___), B_2 (___,___), C_2 (___,___), D_2 (___,___),E_2 (___,___),

Step 6. Draw the new trapezoid, and label Points A_2, B_2, C_2, $D_2,$ E_2.
⇒ What quadrant is this figure in? _____

Step 7. Congratulations! You have completed the task! Take this sheet and your Grid Sheet to the teacher for further instructions.

Scavenger Hunt Grid Sheet

Name _____

1.

A (___, ___) *B* (___, ___) *C* (___, ___)
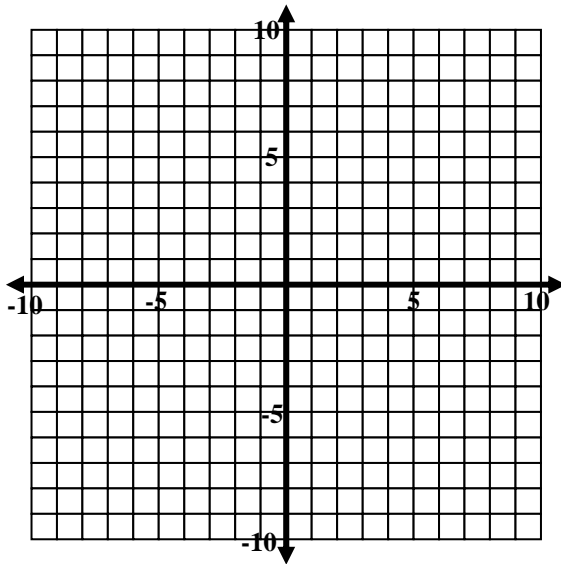
Answer Letter Found on Next Sheet _____

2.

A (___, ___) *B* (___, ___) *C* (___, ___)
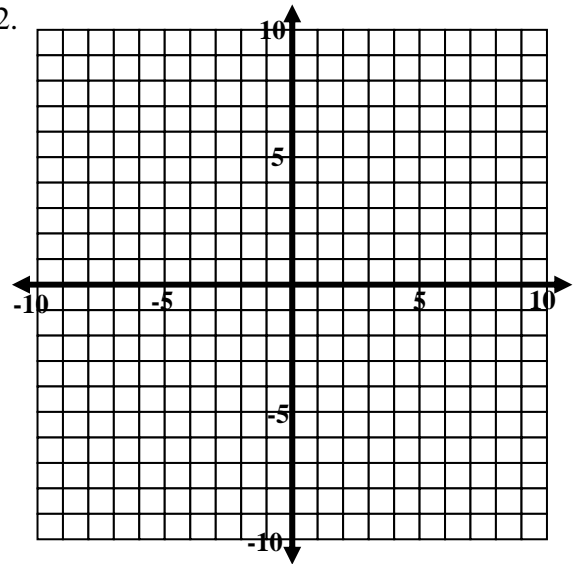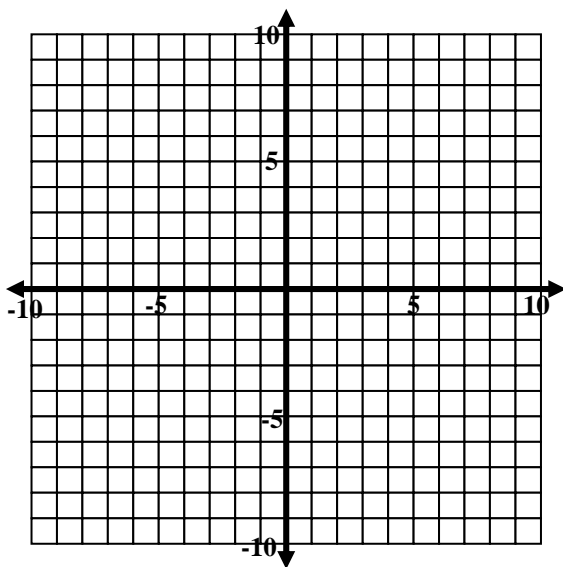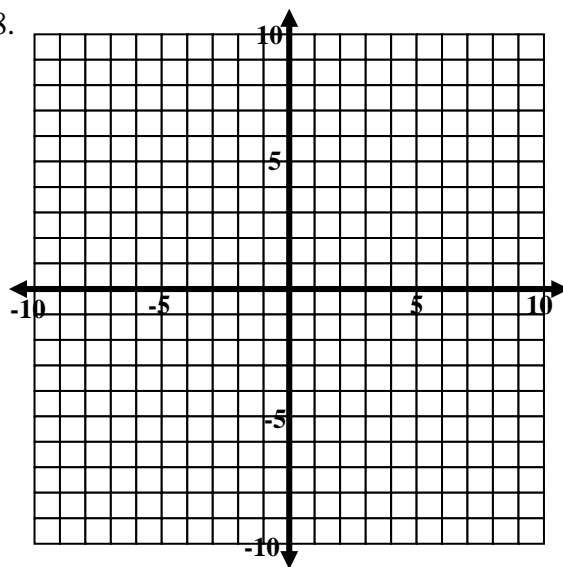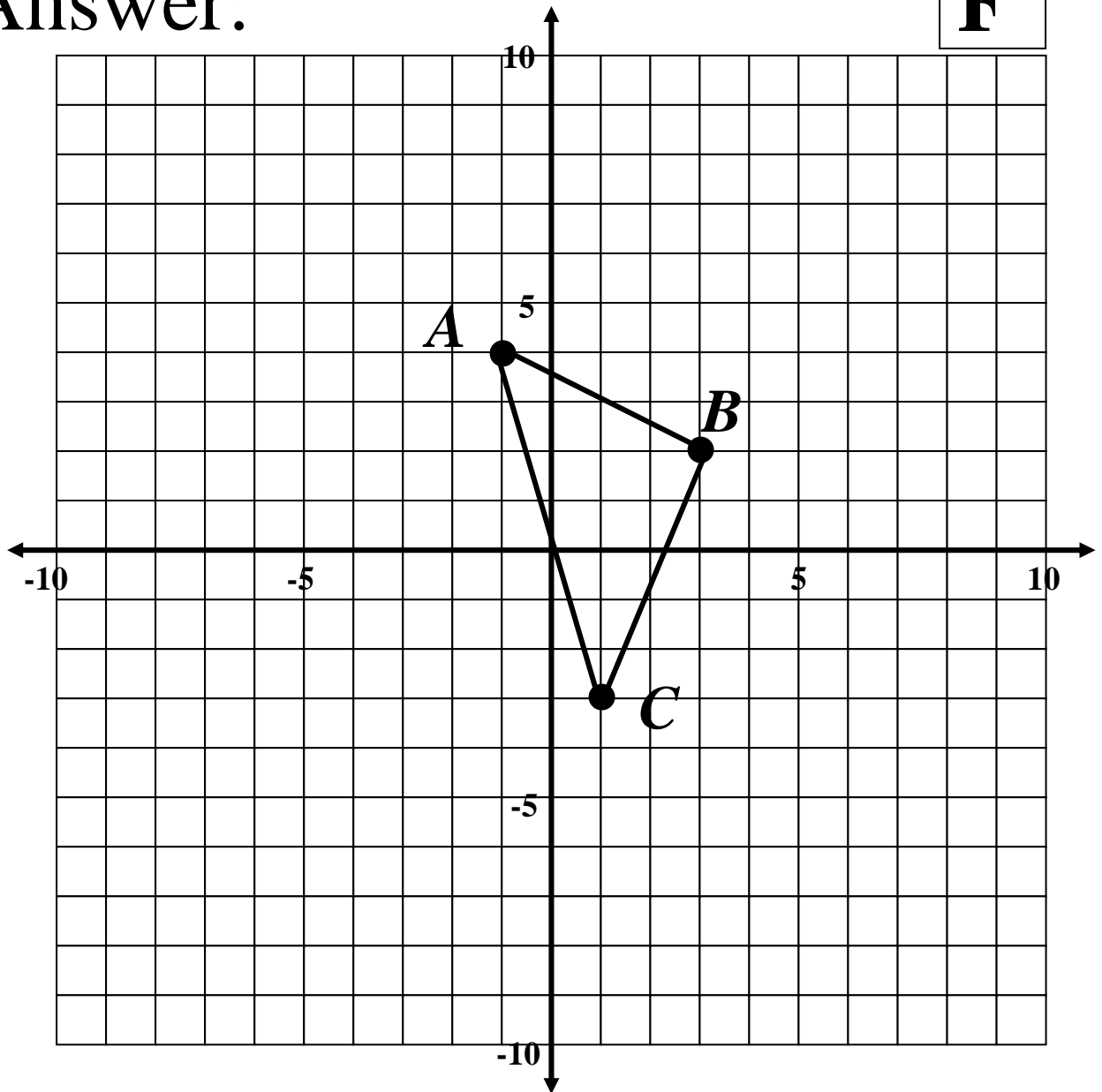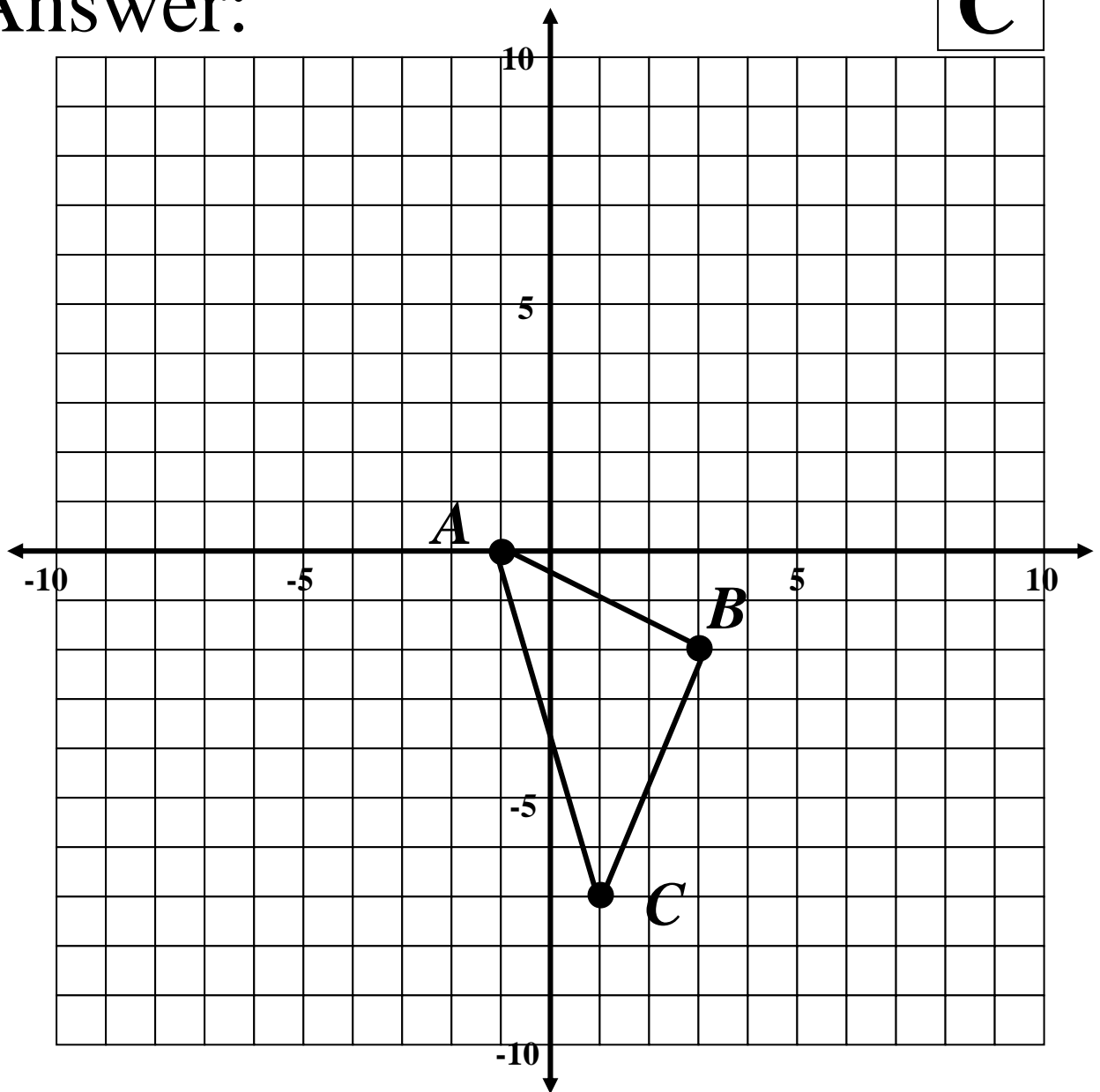
Answer Letter Found on Next Sheet _____

3.

A (___, ___) *B* (___, ___) *C* (___, ___)
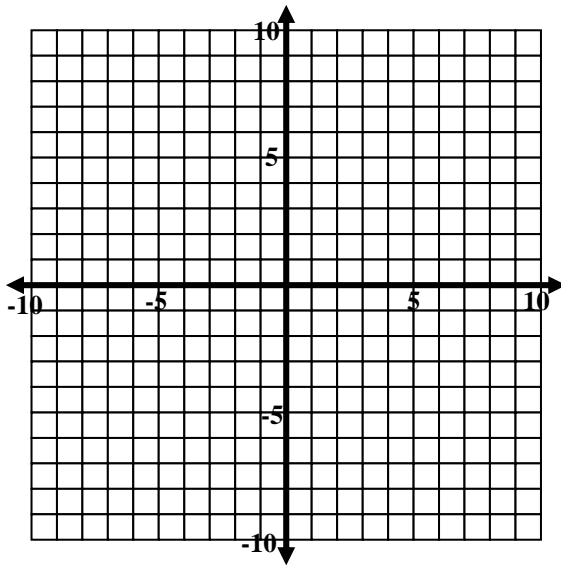
Answer Letter Found on Next Sheet _____

4.

A (___, ___) *B* (___, ___) *C* (___, ___)
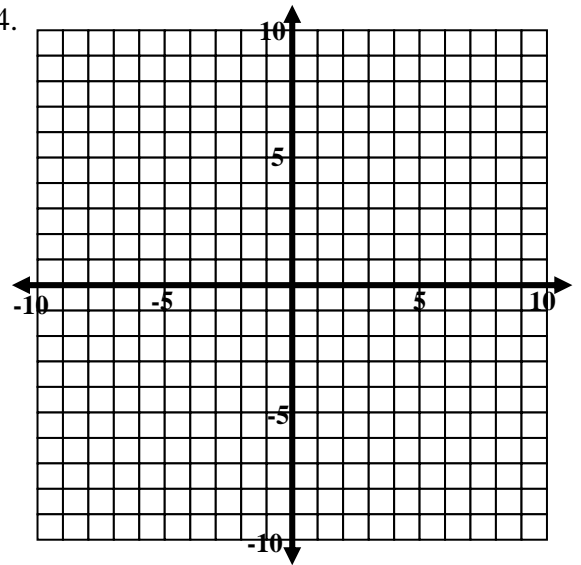
Answer Letter Found on Next Sheet _____

5.

A (___, ___) *B* (___, ___) *C* (___, ___)
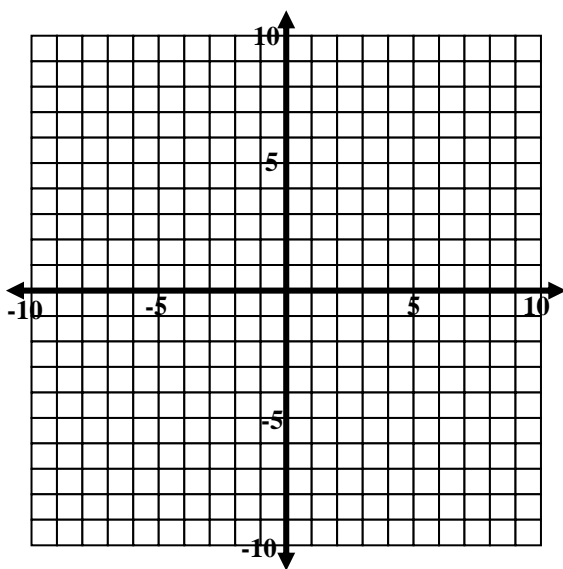
Answer Letter Found on Next Sheet _____

6.

A (___, ___) *B* (___, ___) *C* (___, ___)
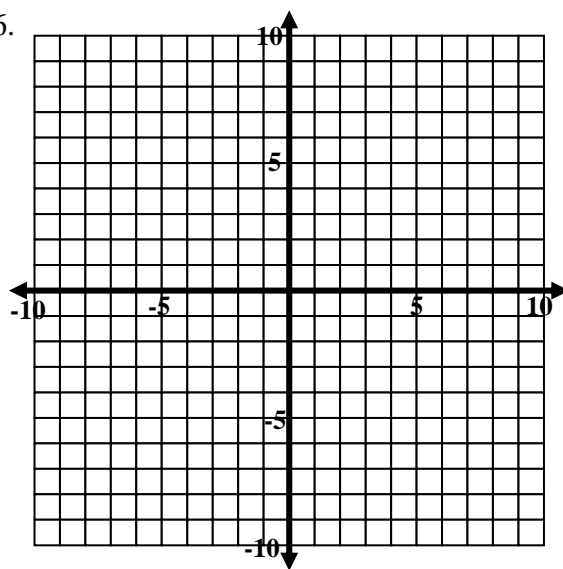
Answer Letter Found on Next Sheet _____

7.

A (___, ___) *B* (___, ___) *C* (___, ___)

Answer Letter Found on Next Sheet _____

8.

A (___, ___) *B* (___, ___) *C* (___, ___)

Answer Letter Found on Next Sheet _____

Answer:

Question:

Translate the polygon above four units down.

Answer:

Question:

Translate the polygon above seven units left.

Answer:
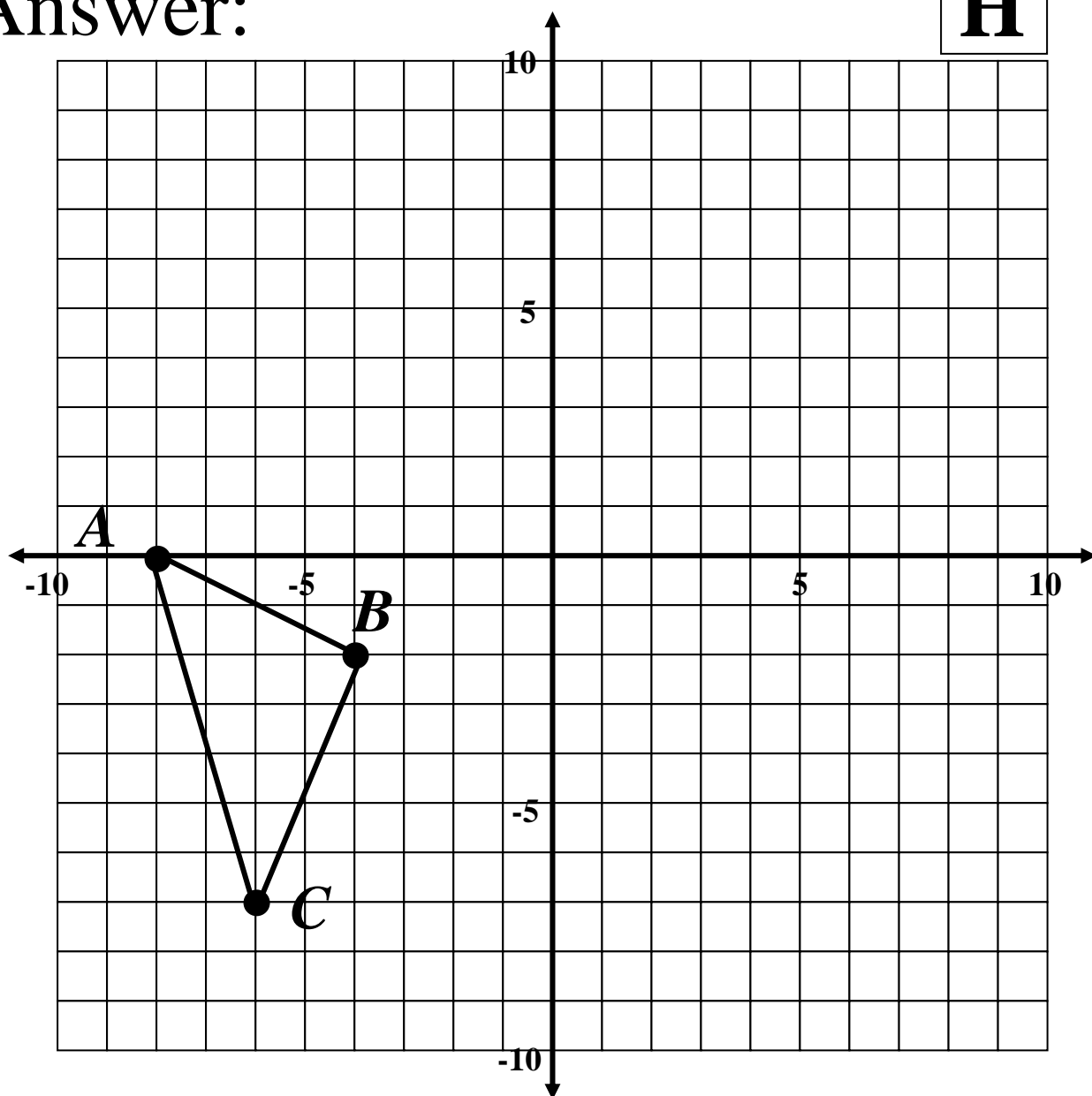
Question:

Reflect the polygon above over the *x*–axis.

Answer:
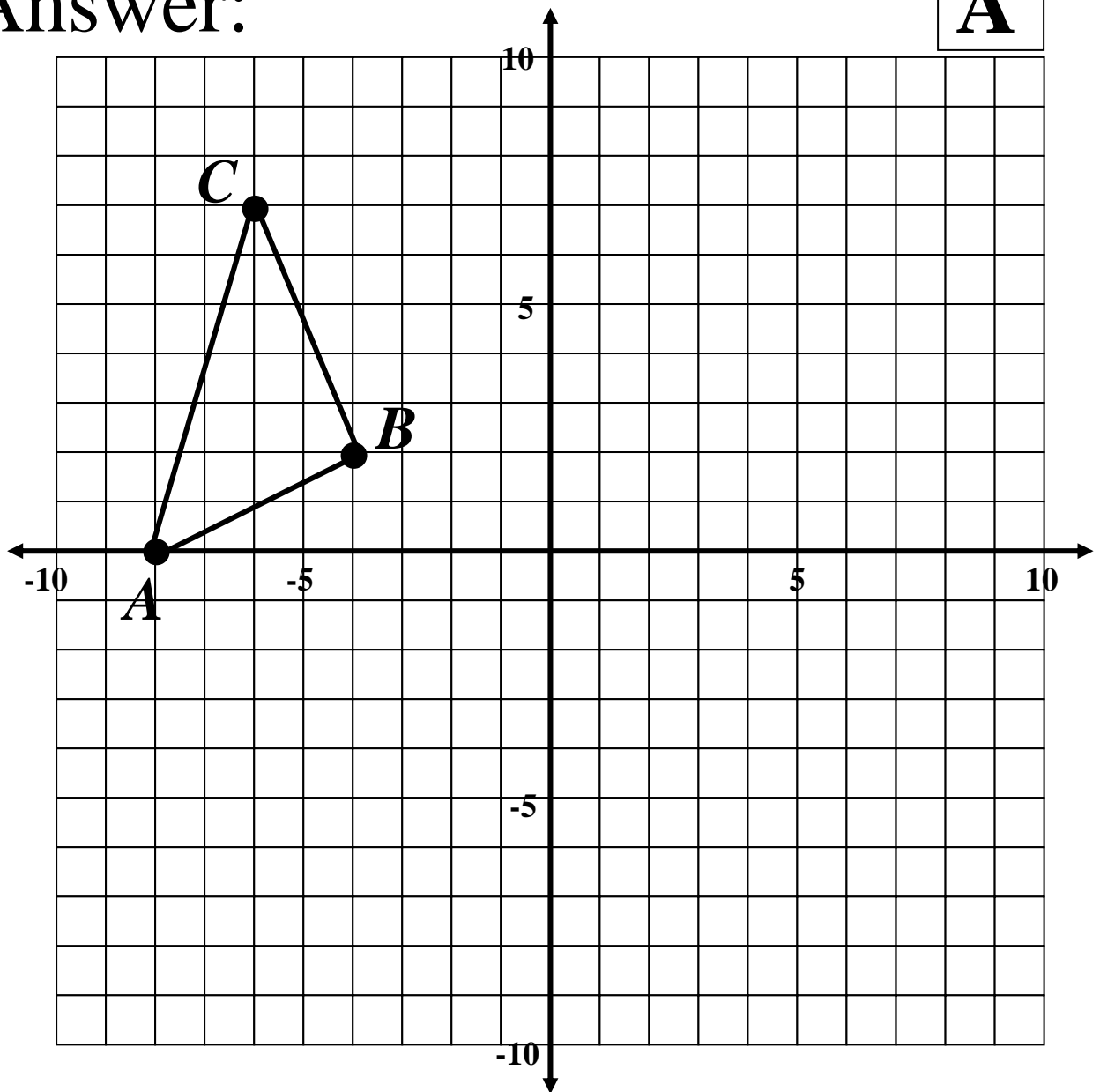
Question:

Translate the polygon above eight units right.

Answer:
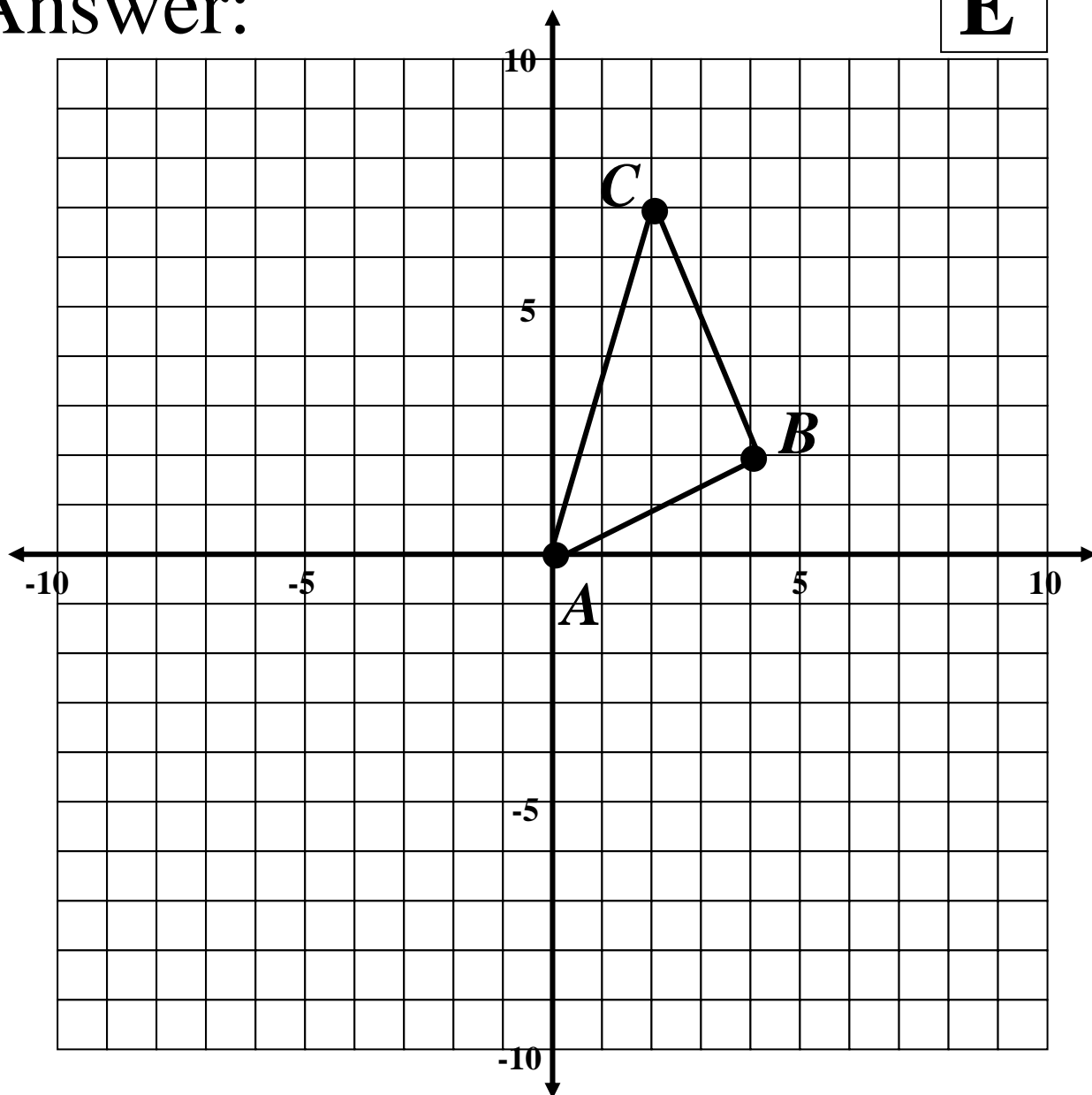
Question:

Rotate the polygon above 90° clockwise.

Answer:
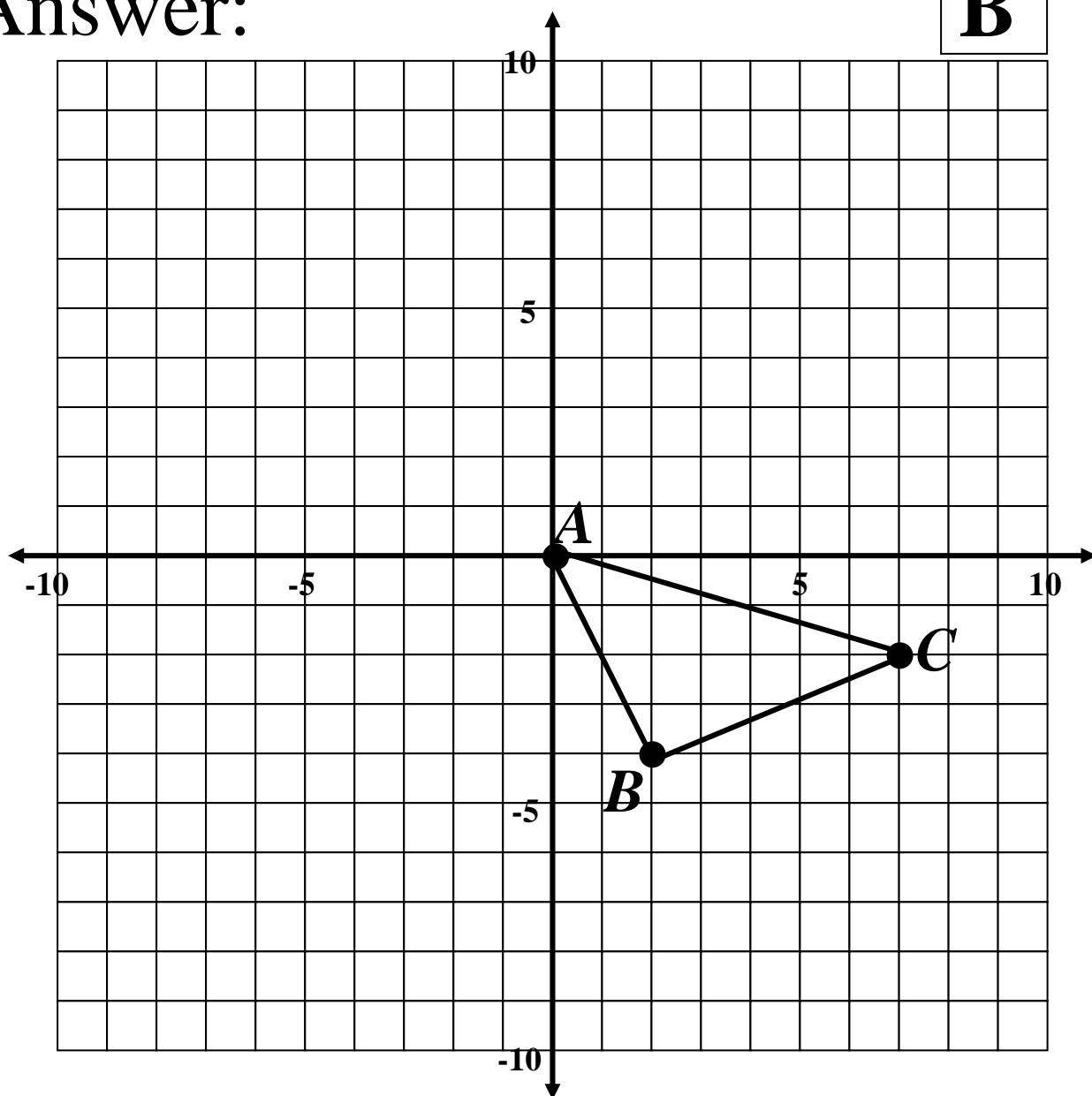
Question:

Reflect the polygon above over the *y*–axis.

Answer:
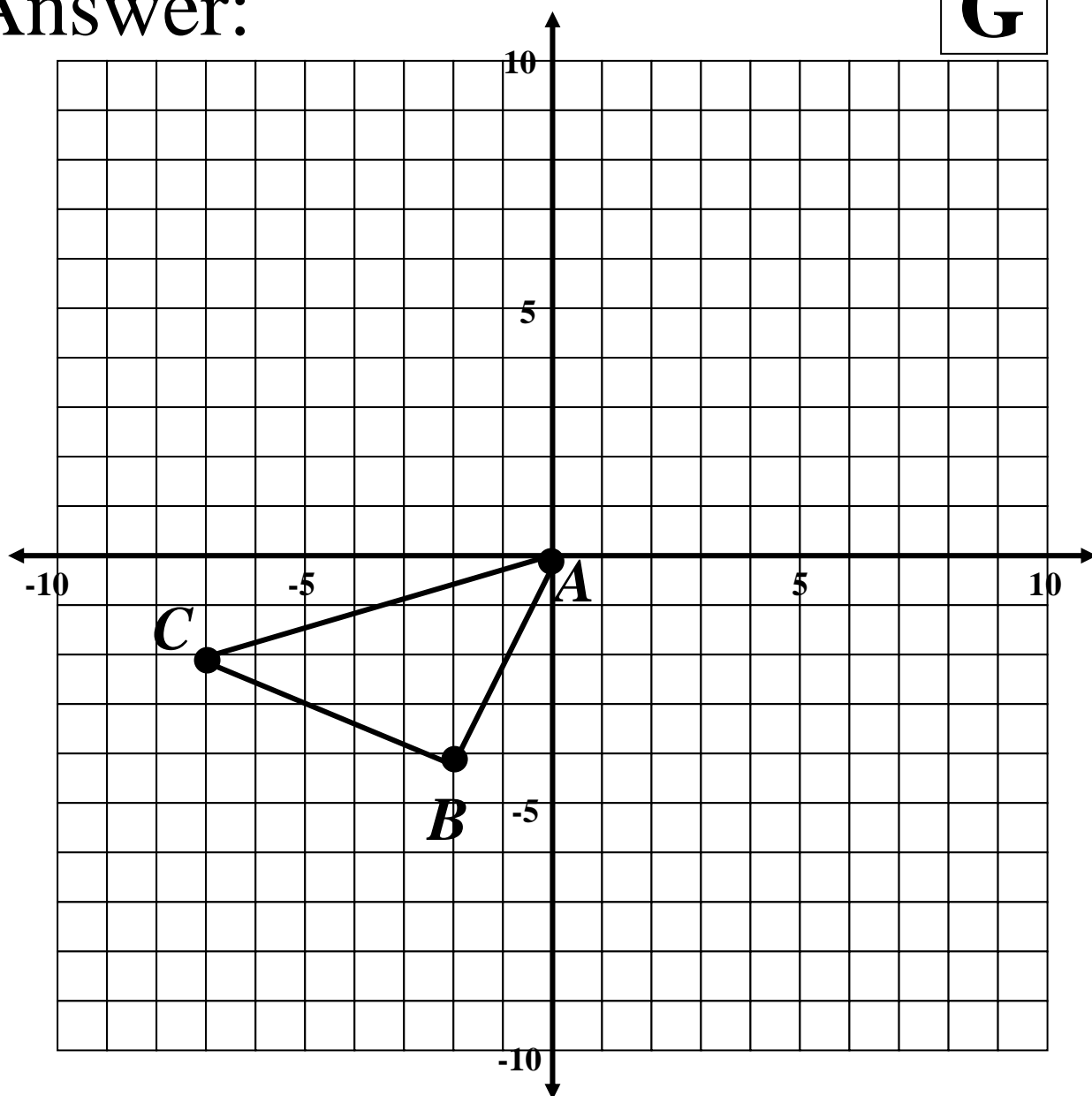
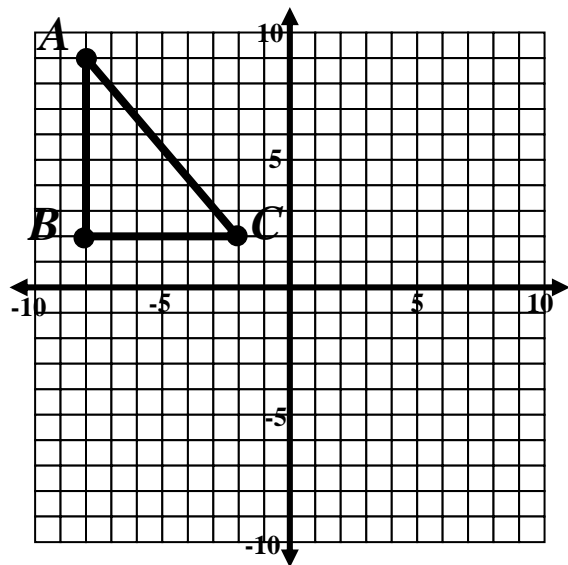# Question:

Rotate the polygon above 180˚ counterclockwise.

Answer:
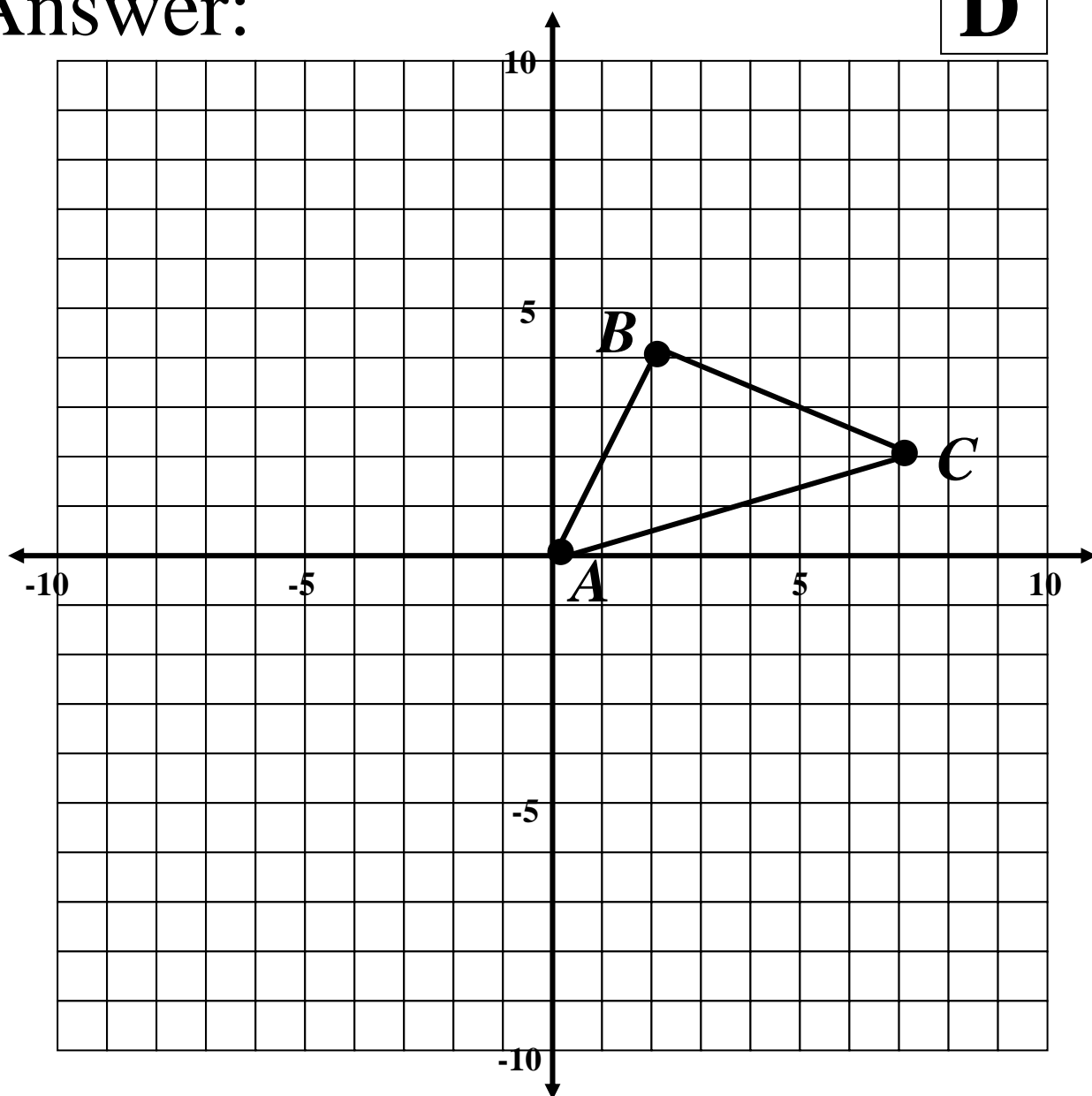
Question:

Draw the polygon formed by the coordinates (3, 2), (–1, 4), and (1, –3).

Find the Image

Name _____
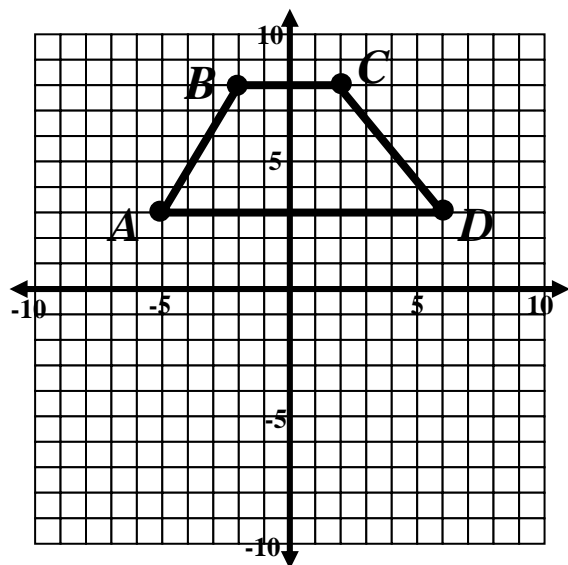
1.

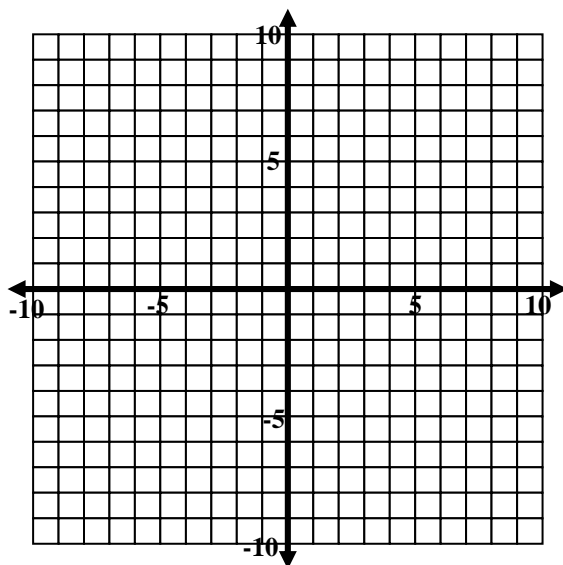Translate the pre–image 8 units to the right and 7 units down. ($x + 8$), ($y - 7$).
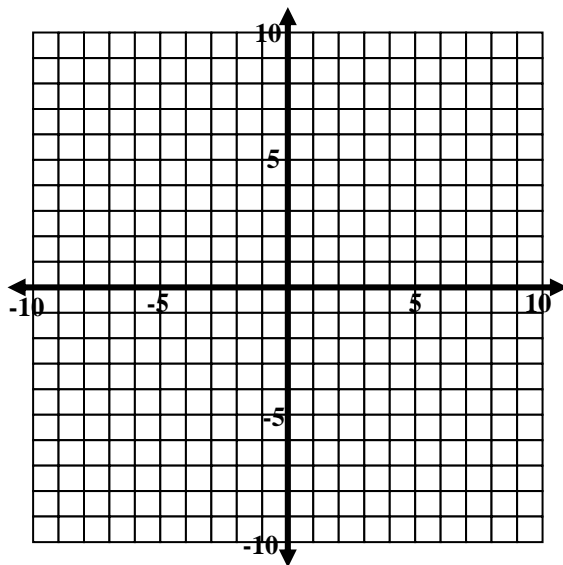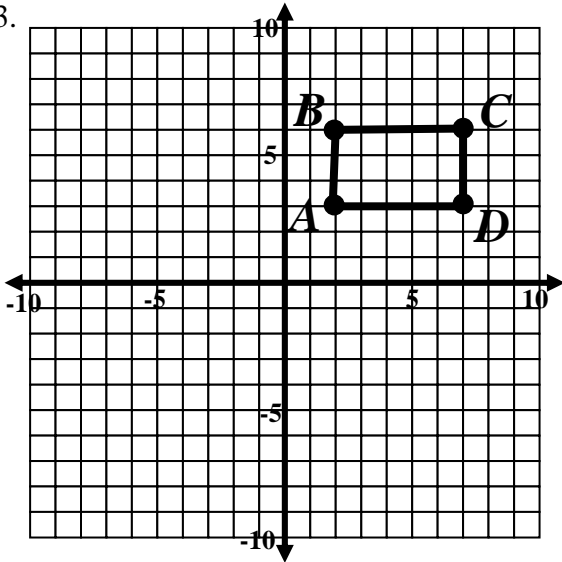

A_1 (__ , __) B_1 (__ , __) C_1 (__ , __)

2.

Reflect the pre–image over the x–axis.

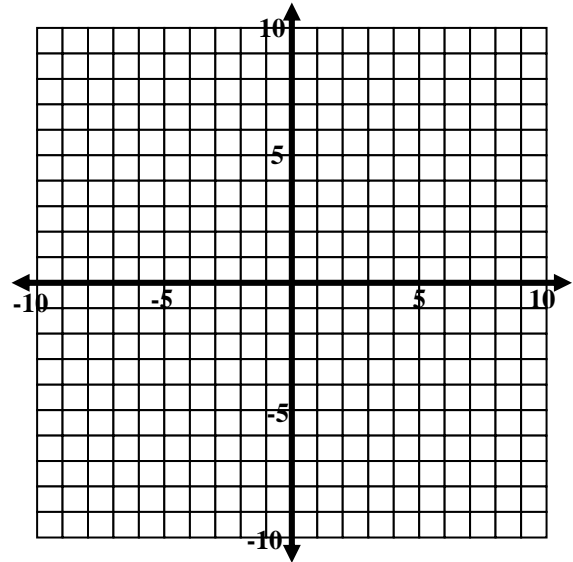A_1 (__ , __) B_1 (__ , __)
C_1 (__ , __) D_1 (__ , __)
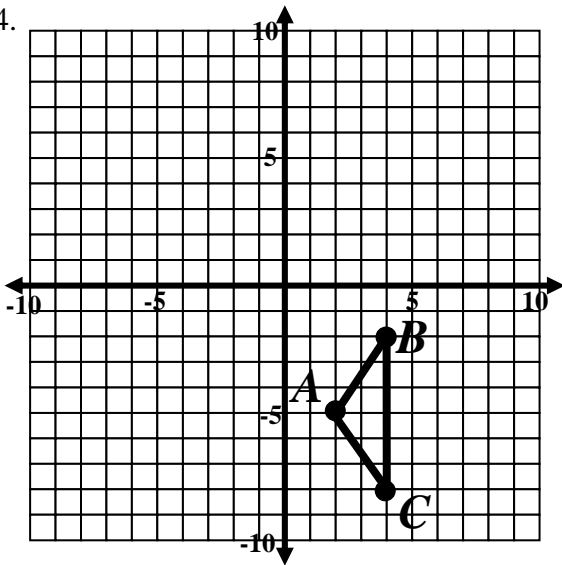
3.

Rotate the pre–image 90 degrees clockwise around the origin.
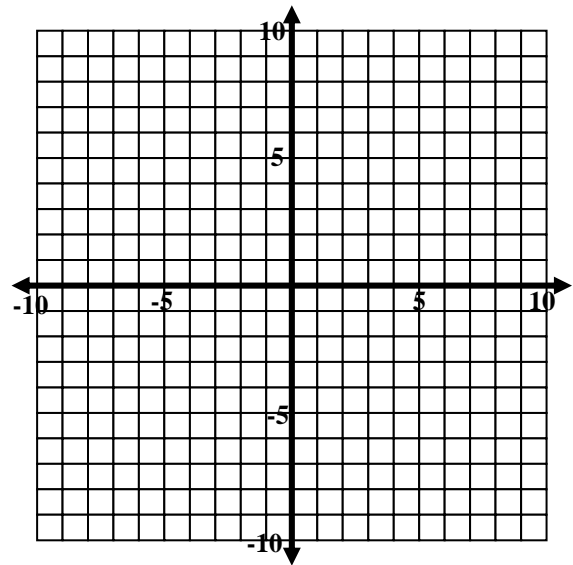
A_1 (__ , __) B_1 (__ , __)
C_1 (__ , __) D_1 (__ , __)

Bonus

4.

Reflect the triangle over the y–axis,
translate 3 units to the left and 10 units up,
and rotate 90 degrees clockwise around the origin.

A_1 (__ , __) B_1 (__ , __) C_1 (__ , __)

Exploring Transformations
Answer Key

Exploring Transformations Translation Station
Step 1: Quadrant I
Step 2: Quadrant III
Step 3: Quadrant II
Step 4: A_1 (–2,–4) , B_1 (–3,–3), C_1 (–9,–3), D_1 (–9,–5), E_1 (–7,–6), F_1 (–4,–5)
Step 5: A_2 (0,6) , B_2 (–1,7), C_2 (–7,7), D_2 (–7,5), E_2 (–5,4), F_2 (–2,5)
Step 6: Answers will vary. The trucks are congruent and maintain the same size and shape. The original truck is in the 1st quadrant, the first image is in the 3rd quadrant and the 4th image is in the 2nd quadrant. The trucks translate or slide across the coordinate plane.
Step 7: You need to slide or translate the truck 9 units to the right and 2 units down. $(x + 9)$, $(y – 2)$.
Step 8: You need to slide or translate the truck 9 units to the left and 2 units up. $(x – 9)$, $(y – 2)$.

Exploring Transformations Reflections
Step 1: Quadrant I
Step 5: (3, –2), (4, –6), (8, –8), (9, –2)
Step 6: Quadrant IV
Step 7: Answers will vary
Step 8: Quadrant III
Step 12: (–3, 1), (–5, 5), (–8, 3)
Step 13: Quadrant II
Step 14: Answers will vary

Exploring Transformations Reflections (2)
Step 1: Quadrant I
Step 5: (–3, 2), (–4, 6), (–8, 8), (–9, 2)
Step 6: Quadrant II
Step 7: Answers will vary
Step 8: Quadrant III
Step 12: (3, –1), (5, –5), (8, –3)
Step 13: Quadrant IV
Step 14: Answers will vary

Exploring Transformations Rotations
Step 1: Quadrant II
Step 5: A_1(1,2), B_1(1,9), C_1(4,6), D_1(4,3)
Step 6: Quadrant I
Step 8: A_2(2,–1), B_2(9,–1), C_2(6,–4), D_2(3,–4)
Step 9: Quadrant IV

Exploring Transformations Rotating a Triangle
Step 1: Quadrant I
Step 5: $A_1(8,–2)$, $B_1(6,–6)$, $C_1(1,–4)$
Step 6: Quadrant IV
Step 8: $A_2(–2,–8)$, $B_2(–6,–6)$, $C_2(–4,–1)$
Step 9: Quadrant III

Exploring Transformations Rotating a Pentagon
Step 1: Quadrant I
Step 5: $A_1(3, –2)$, $B_1(5,–3)$, $C_1(4,–5)$, $D_1(7,–8)$, $E_1(1,–6)$
Step 6: Quadrant II
Step 8: $A_2(–2,–3)$, $B_2(–3,–5)$, $C_2(–5,–4)$, $D_2(–8,–7)$, $E_2(–6,–1)$
Step 9: Quadrant III

Scavenger Hunt
F, C, H, A, E, B, G, D
F: $A(–1, 5)$, $B(3, 2)$, $C(1, –3)$
C: $A(–1, 0)$, $B(3, –2)$, $C(1, –7)$
H: $A(–8, 0)$, $B(–4, –2)$, $C(–6, –7)$
A: $A(–8, 0)$, $B(–4, 2)$, $C(–6, 7)$
E: $A(0, 0)$, $B(4, 2)$, $C(2, 7)$
B: $A(0, 0,)$, $B(2, –4)$, $C(7, –2)$
G: $A(0, 0)$, $B(–2, –4)$, $C(–7, –2)$
D: $A(0, 0)$, $B(2, 4)$, $C(7, 2)$

Find the Image
1. $A_1 (0, 3)$, $B_1 (0, –5)$, $C_1 (6, –5)$
2. $A_1 (–5, –3)$, $B_1 (–2, –8)$, $C_1 (2, –8)$, $D_1 (6, –3)$
3. $A_1 (3, –2)$, $B_1 (6, –2)$, $C_1 (–7, –7)$, $D_1 (3, –7)$
4. $A_1 (5, 5)$, $B_1 (8, 7)$, $C_1 (2, 7)$